NEURAL NETWORKS AND FUZZY SYSTEMS

NNFS-CW1

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# Introduction

In this report we will use neural network to diagnose a disease named as breast cancer. Every year millions of people died due to cancer, some of them are not even got to know till then they reach on final stage of disease. Breast cancer is type of cancer which is not only an issue in third world countries but also a caused huge problem in developed countries. If we are able to detect breast cancer in early stages then we will able to save number of lives. We will use “Wisconsin breast cancer data set” and apply on our developed neural network to evaluate its accuracy. We will develop some hypothesis experiment on them and produce final results. A lot of work has already been done in the field of artificial intelligence especially using neural network in quest to detect disease in early stage and developed a system which could work without any interference of human being once they are well trained with initial data.

# Relevant study

Lot of research work has done in computer science using artificial intelligence and neural network.so we will going to discuss some relevant study which is used to detect breast cancer using the same “Wisconsin breast cancer data set” and producing the optimized result.

In this paper they try to detect the cancer stage using clustering techniques. For this purpose they used adaptive resonance neural network (ARNN) a special case of unsupervised learning. A vigilance parameter (vp) in ARNN defines the stopping criterion and hence helps in manipulating the accuracy of the trained network. They used the Wisconsin breast cancer database which contains total 699 cases but they used 600 cases to trained the network in this data set 375 were benign cases and 225 as malignant cases. Final results find out that they have accuracy of 82.64 with the Precision of 79 percent on their prescribed method.[1]

Another research paper works on neural network used to detect breast cancer. For this they used the extreme machine learning techniques on artificial neural network so that they could produce more efficient result .they used the same dataset of Wisconsin breast cancer data set. Final results showed that Extreme Learning Machine Neural Networks (ELM ANN) has better generalization classifier model than basic Gradient-Based Back Propagation Artificial Neural Networks (BP ANN).these Gradient-Based Back Propagation Artificial Neural Networks (BP ANN) has lot of limitations such as parameters to be set in the beginning, long time for training process, and possibility to be trapped in local minima.[2]

# Neural network

A neural network could be define in simple words as a computer system modeled on working of human brain cell and nervous system.it is actually patterned on operation of neurons in human brain cell. Neural network working on different number of processes and arranged them in different levels of layers. In other words, an artificial neuron is a device with several inputs and one output that models certain properties of biological **[3]**. The first layer receive the raw input as information following the working of brain cells, each successive layer receive the output of proceeding layer. The last layer produces the output of the system. All these layers are very well interconnected furthermore these neural networks are adaptive which means they could modify themselves as they learn from initial training. In the layers of these networks each layer has number of nodes. These nodes has its own small sphere of knowledge which may be what it has seen or any kind of rules on which these nodes programed with or developed for itself. These networks depends on weighting of input streams which is how each node be given weight according to the significance of its contribution from each of its antecedents. Data sources which are helpful in finding the right solution are weight higher. Initially we fed this neural network large amount of data or trained them. Training is providing input and informing the network what kind of output should be.

# Breast cancer

There are 100 types of cancer but we will try to diagnose a type, which is named as breast cancer. There are two main stages of cancerous tumors one is benign and other is malignant. If the cancerous tumor are in benign stage they could be detected are diagnosed a bit easily but once the cancer get into the malignant sage then it is very difficult to detect or diagnose and in some cases it is impossible.

Breast cancer is a type of cancer which occurs in tissue of breast .it may occur on both male and female but more number of cases reported in females. Breast cancer usually occurs when some breast cells start to develop unusually. These cells develops in more rapid way as compare to healthy cells and form a lump or mass. Almost 246,000 women are affected by breast cancer or 1 in 8 diagnosed with disease in united states each year **[4].** After skin cancer it is considered as second most common cancer in America.

It is such as important issue that number of lives are relatively connected to the solution of this problem because it is the second leading cause of deaths worldwide.so let’s see how we can we solve this issue using neural network.

# Technical Approach

The Wisconsin Breast Cancer dataset from the Machine Learning UCI repository is used to diagnose and detect the breast cancer disease in human. It contains 700 patients’ test cases approximately. It consist of 11 columns in which 1st column represents the patient ID, from 2nd column to 10th column the dataset contains different tests like clump size etc. and last column represents the condition of disease (2 for benign and 4 for malignant in the whole dataset). To make this dataset useful, excluding the 1st and the last column, we stored the dataset as input data and the last column as output data. In order to train & test the neural network using the dataset mentioned above. We divided it into two parts, one for training and other for testing. Amount of data used to train and test also matters a lot in neural network. For example, 20% dataset for training and 80% dataset for testing and vice versa. The list with different values is created that will be used to get the specific amount of test cases from the Wisconsin Breast Cancer Disease dataset. Then, Input data is further divided into training and testing inputs and output data is divided into training and testing outputs. Then, training inputs & outputs are passed as an argument to neural network function ‘newff’. The activation functions used to achieve the required output results are ‘tansig’ & ‘logsig’. The training functions used in it are ‘trainr’, ‘learngd’. The number of hidden layers chosen initially is 10. The goal of a neural network is set to 0.01. While the epochs were set to 100 then, the neural network starts training itself. Then, it is tested on a different dataset. After processing, it generates some output results which are stored in a variable list. To compare the results generated by the neural network and test output, the counter increments each time when the dataset produces same value and if not it neglects the increment. Now, the final step is to calculate its accuracy. In order to do that counter is divided with the size of the total number of test outputs and multiplied by 100 to get the percentage.

# Experiments & Results

Now, using the above approach, I have used different assumptions and based on these hypotheses, I have performed different experiments on the Wisconsin Breast Cancer dataset in order to get the better results. On the very first, the numbers of hidden layers were fixed to 10. The amount of training input data used is 20% and testing data is 80%. The activation function used is ‘tansig’ with the training functions ‘learngd’ & ‘trainr’. The accuracy measured by the following set of input parameters is 97.4%. After changing the amount of training and testing datasets, the outcomes vary. As found in the figure 1, the more the training dataset provided to the neural network for training, the more accurate it generated the results that were close to truth. As can be clearly seen in the figure mentioned below:

|  |  |  |  |
| --- | --- | --- | --- |
| Train Data% | Test Data% | Epochs | Accuracy |
| 20% | **80%** | 100 | 94.7% |
| 40% | **60%** | 100 | 95.2% |
| 70% | **30%** | 100 | 98.1% |
| 90% | **10%** | 100 | 97.9% |

## Hypothesis-2

Now, the next hypothesis is based on hidden layers used in the neural network. If we change the number of neurons in hidden layer, the accuracy will also get affected. The number of neurons is kept under the range of input layer and output layer neurons. By decreasing or increasing the number of neurons, accuracy should also increase and decrease as it is directly proportional to it. Activation functions are ‘tansig’, ‘tansig’, and training function is ‘trainr, learngd’. Here, training & testing data is fixed but number of neurons in hidden layers varies in order to validate the change in accuracy.

|  |  |  |  |
| --- | --- | --- | --- |
| Neurons in Hidden Layers | Training Data % | Testing Data % | Accuracy % |
| 2 | 40 | 60 | 97.9 |
| 4 | 40 | 60 | 97.7 |
| 6 | 40 | 60 | 97.9 |
| 9 | 40 | 60 | 98.2 |
| 12 | 40 | 60 | 95.98 |
| 15 | 40 | 60 | 93.12 |

The results are same as hypothesis that increasing the number of hidden layers in the neural network will cause the decrease in the accuracy of outcomes.

Based on these results mentioned above, the basic core features were implemented while for testing, the command line instructions were used. For example, different distributions were calculated manually and entered as input for the function. The parameters were changed inside the respective functions. For testing, the initial weights were kept the same for every network created. The first initial weights were saved through the provided function. This was done in order to check the results of an attribute separately while keeping the rest of the properties was kept constant and this process was repeated for every experiment.

## Hypothesis-3

Following are the effects of changing the transfer functions on accuracy and error

The logsig function has a range of zero to one, i.e. it is unipolar in nature. The tansig function is opposite of the logsig function as its ranges from -1 to 1. For our network, we should use logsig function as we don’t require negative values.

If we use logsig on both, the hidden layer and the output layer, we should get maximum accuracy. Reason being that tansig returns insignificant values for some of the cases.

|  |  |  |
| --- | --- | --- |
| Activation functions (hidden layer, output layer) | Accuracy% | Error% |
| Logsig, logsig | 99.1 | 0.86 |
| Logsig, tansig | 98.5 | 1.45 |
| Tansig, logsig | 97.0 | 2.90 |
| Tansig, tansig | 94.1 | 5.89 |

# Result:-

As predicted from the above figure, the best result is displayed, when we use logsig for both the hidden and the output layers.

# Conclusion:-

In this problem we were try to develop an optimized neural network which could be used to detect the breast cancer. After testing three different types of hypothesis we could find the maximized solution which we could we see in the results such as when we use logsig logsig for the both hidden layer and output layer accuracy remains to 99.1 percent and error percentage was only 0.86 percent.

# References:-

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[2] C. P. Utomo, A. Kardiana, and R. Yuliwulandari, “Breast Cancer Diagnosis using Artificial Neural Networks with Extreme Learning Techniques,” *Int. J. Adv. Res. Artif. Intell.*, vol. 3, no. 7, pp. 10–14, 2014.

[3] - (<http://www.futura-sciences.us/dico/d/computer-science-artificialneuron-50004879/>)

[4]- FACEP, J. R. (n.d.). Breast Cancer Causes, Types, Signs, Symptoms, Stages, Treatment. Retrieved November 22, 2017, from (<https://www.medicinenet.com/breast_cancer_facts_stages/article.htm>)